5.3.1 Simple harmonic oscillations

	Learning outcomes	Additional guidance
	Learners should be able to demonstrate and apply their knowledge and understanding of:	
(a)	displacement, amplitude, period, frequency, angular frequency and phase difference	M4.7 HSW8
(b)	angular frequency ω; $\omega = \frac{2\pi}{T}$ or $\omega = 2\pi f$	
(c)	(i) simple harmonic motion; defining equation $a = -\omega^2 x$	HSW5
	(ii) techniques and procedures used to determine the period/frequency of simple harmonic oscillations	PAG10 e.g. mass on a spring, pendulum
(d)	solutions to the equation $a = -\omega^2 x$ e.g. $x = A\cos\omega t$ or $x = A\sin\omega t$	M3.9, M3.12
(e)	velocity $v = \pm\omega\sqrt{A^2 - x^2}$ hence $v_{max} = \omega A$	M2.2
(f)	the period of a simple harmonic oscillator is independent of its amplitude (isochronous oscillator)	
(g)	graphical methods to relate the changes in displacement, velocity and acceleration during simple harmonic motion.	HSW1

(6) M - Describe oscillations in terms of key terms
(7) S - Calculate the frequency and phase difference of an oscillator
(8) C - Define simple harmonic motion and relate the definition to the equation.

Lesson 1. Oscillations and SHM

STARTER: How many examples of oscillations can you think of?

Pendulum. Piston. Atom Vibration. Mass on a Spring.

Kilo 10^3
Mega 10^6 How do you define an oscillation? What characteristics do they have?
Giga 10^9

Key point
Repeating motion
about an equilibrium position
Restoring force needed.

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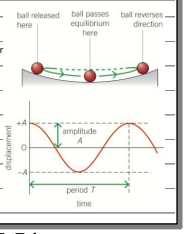
ACTIVITY: Make a table to show key measurable variables for oscillations. Include the **symbol, unit** and **definition.**

Kilo 10^3 Displacement / amplitude / period / frequency
Mega 10^6
Giga 10^9 Are there any other important motion terminology for comparing two separate oscillations? What is the definition?

Key point

Quantity	Symbol and unit	Definition
displacement	x / m	the distance from the equilibrium position
amplitude	A / m	the maximum displacement from the equilibrium position
period	T / s	the time taken to complete one full oscillation
frequency	f / Hz	the number of complete oscillations per unit time

Phase Difference
The fraction of an oscillation between the vibrations of two oscillating particles/objects, expressed in degrees or radians.



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Angular frequency

Explain in your own words, how circular motion and oscillating motion are related.

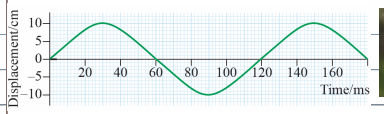
SHM animation kerboodle upto 2.30

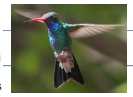
Key point
Oscillating object also have an angular frequency given by....

$\omega = \frac{2\pi}{T}$ or $\omega = 2\pi f$

Example: What is the angular frequency of oscillation of a humming birds wing?

Ex: What does it mean to express this as rads^{-1} ?





$\omega = \frac{2\pi}{T} = \frac{2\pi}{0.12} = 52 rads^{-1}$

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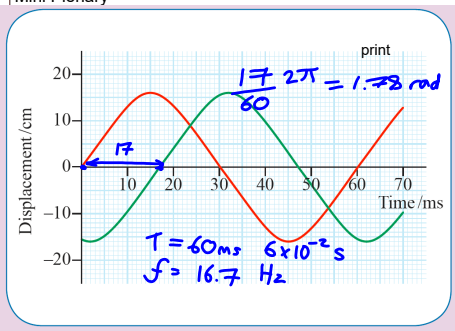
Mini Plenary



Key point

a) the graph shows a displacement time graph of 2 oscillations. What characterises an oscillation? give an example

b) What is the time period?

c) Calculate the frequency.

d) Find the phase difference in radians and degrees.

Ex: Lowe Exercise 11.1

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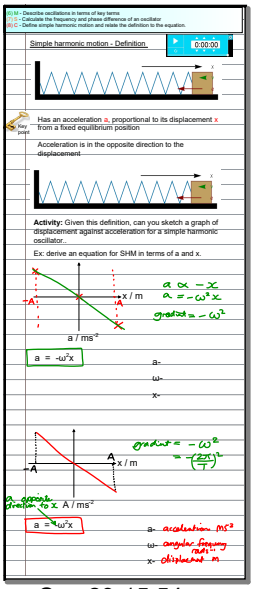

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ACTIVITY: Summary Questions P319

Kilo 10^3
Mega 10^6
Giga 10^9 Lowe: 11.1 p87

Key point

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Plenary - maths

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17 A short pendulum oscillates with s.h.m. such that its acceleration a (in $\mathrm{m\,s^{-2}}$) is related to its displacement x (in m) by the equation $a = -300x$. Determine the frequency of the oscillations.

Answer

$2.76\,\mathrm{Hz} \approx 2.8\,\mathrm{Hz}$

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